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Does no-till soybean farming provide any benefits for birds?

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ABSTRACT

Nesting success and avian communities were compared between tilled and no-till soybean fields in Illinois. No-till had greater densities of birds than tilled fields, and the overall community in no-till was of greater conservation value due to more grassland birds using no-till compared with tilled fields. Nesting density was greater in no-till (4.5 nests/100 ha) than in tilled (1.6) fields. The most common nesting species were American robins, vesper sparrows, and mourning doves. Nest success, as estimated from daily survival rates, was 19.4% in no-till and 9.4% in tilled fields. Predation was the main cause of nest failure, but 24.4% of failures were caused by farm machinery. The authors propose that the previous year's crop residue and greater abundance of weedy plants in no-till resulted in increased nesting and foraging activity in no-till and greater nest success because of increased opportunity to conceal nests in no-till compared to tilled fields. No-till provides greater benefits to birds than tilled fields, and the large amount of acreage in row crops dictates that we understand the contribution of no-till fields to grassland bird populations.

1. Introduction

Declines in the diversity and abundance of wildlife have followed intensification of agriculture and homogenization of habitat (Peterjohn and Sauer, 1999; Benton et al., 2003). While these effects have been observed in South America (Schrag et al., 2009) and Europe (Donald et al., 2001), declines of birds in the Midwestern United States have been dramatic due to intensive row cropping (Wooley et al., 1985; Warner, 1994). In particular, declines of grassland birds have largely resulted from conversion of grasslands to row crops (Warner, 1994). Over the last 30 y, grassland birds have experienced one of the most consistent and widespread declines of any other bird group in North America (Sauer et al., 2011). Nonetheless, alternative cropping practices, such as no-till, may offer better prospects for wildlife relative to more intense tillage practices (i.e. conventional tillage) and could provide conservation benefits to birds.

Use of no-till has increased across the United States since the 1980s, with estimated annual increases of 1.5% since 2005 (USDA-ERS, 2010). Up to 50% of soybeans in Illinois are currently planted under no-till with even greater proportions in other Midwestern states (CTIC, 2010). Whereas the primary driver for no-till practices is soil and water conservation and associated economic benefits (Cannell and Hawes, 1994), a secondary benefit may be enhanced wildlife habitat. Bird surveys in Europe have shown that broad scale changes in farming practices, such as enrollment areas for a targeted management practice such as crop stubble, can increase farmland bird populations (Doxa et al., 2010; Baker et al., 2012).

Despite continued increase of no-till, only one study in the past 30 y has explicitly investigated the role of soybean no-till in the nest density and success of birds (Basore et al., 1986); greater nest densities were found in no-till than tilled fields. Several studies have documented greater avian abundance and species richness in no-till compared with tilled corn and soybean fields (Castrale, 1985; Walk et al., 2010a). Studies in other areas of the United States in different crops (ex. wheat, sunflowers, fallow) have also documented benefits of no-till for breeding ducks (Duebbert and Kantrud, 1987) and greater songbird nest densities in minimum tillage and no-till compared with conventionally tilled crops (Lokemoen and Beiser, 1997; Martin and Forsyth, 2003). These studies, however, do not provide daily survival estimates, making comparisons across studies and habitats difficult.

Vegetation diversity and structure likely drive patterns of increased bird and nest density in minimum and no-till fields (Wray and Whitmore, 1979; Castrale, 1985; Flickinger and Pendleton, 1994). Warner et al. (2005) found that "cleaner" agricultural practices, such as intensive weed and shrub management in and around crop fields, have resulted in agricultural areas becoming less appealing for birds, resulting in lower avian diversity and density. Birds could experience reduced nest success if nests are initiated before tillage and planting operations, creating an ecological trap (Best, 1986). In Illinois soybeans tillage operations most often occur

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in the fall, thus eliminating the effect of tillage as the mechanism for an ecological trap in crops and making the mechanical disturbance associated with planting the crop the primary farming operation that could cause nest failure. Given the large acreage of row crops, the potential for no-till practices to be of greater value than traditional approaches, and the potential for soybeans planted via no-till methods to create an ecological trap, there is a pressing need to understand the viability of bird populations under alternative tillage practices (Johnson et al., 2011).

The density and relative conservation value of bird communities, as determined by regional conservation priorities (Carter et al., 2000), were compared between no-till and tilled soybean fields. Differences between nest density and nesting success of birds in tilled and no-till soybean fields were explored. Daily survival rates of nests were estimated and three model sets were evaluated to determine the factors associated with: (1) overall nest survival in soybeans, (2) the role of predator behavior in nest survival, and (3) the role of farming activity in nest survival. The nest survival estimates of this study were compared with studies in grasslands embedded within landscapes dominated by row crops. Finally, how soybeans, particularly no-till fields, may contribute to bird conservation in agricultural landscapes is discussed.

2. Methods

Field work was conducted in soybean fields in two counties (McLean and Champaign) in east-central Illinois from 2011 to 2012. Both areas were dominated by corn (*Zea* sp.) and soybeans (*Glycine* sp.). Twelve fields were sampled each year, six no-till and six tilled, for a total of 24 fields. Average size of no-till fields was 20.9 ha (SD 7.5 ha, range 9.2–32.0 ha) and 18.0 (SD 5.6, range 14.0–32.0) for tilled. Land cover in both areas contained over 85% cultivated land, with less than 5% land cover consisting of forest, wetlands, and grasslands combined (USDA NASS, 2012). Three no-till and three tilled fields were selected in each county, or "region", each year. The landscape surrounding each field was comparable and comprised of similar proportions of tilled and no-till areas.

Soybeans were planted into corn stubble each year regardless of tillage practice. "Tilled" fields were generally under conservation tillage practices; a minimum of 30% residue from the previous crop year was left on the soil surface at the time of planting. Fields were tilled with chisel plows in fall, spring, or both. Tilled fields were often leveled with a cultipacker to smooth the soil surface, but the degree in which this practice was applied varied according to farmer preferences. Any spring tillage activity occurred immediately before a field was planted. "No-till" fields received no tillage, and soybeans were directly drilled into the soil surface between rows of standing corn stubble. Row width of fields varied between 8 cm and 30 cm. In 2011, no-till fields were planted between 10 May and 4 June, and tilled fields were planted between 18 May and 11 June. In 2012, no-till fields were planted between 8 May and 15 May, and tilled fields were planted between 1 May and 25 May. The only farming activities observed after planting were applications of a non-selective glyphosate herbicide.

2.1. Field sampling

Bird densities were estimated on all fields by traversing fixed-width line transects (Buckland et al., 2001). Transects were established in ArcMap (ArcMap for Windows, version 10.0; ESRI, Redlands, California) and overlaid on aerial photos of each field. The number and length of transects per field was based on the size and shape of the field. The number of transects per field ranged from 1 to 3, while the length of transects varied from 250 m to 700 m. Birds that were seen or heard perched within 50 m of transect lines were counted, and the perpendicular distance to the transect was estimated for each bird. Surveys were conducted between sunrise and approximately 10:00 h when songbirds are most active. Six surveys were conducted at all sites each year between 10 May and 10 July.

To determine if the community of birds using no-till was of greater conservation value than that of tilled fields, the avian conservation significance (ACS) value was calculated for no-till and tilled fields (Nuttle et al., 2003; Twedt, 2005), using relative species' density. The ACS value is calculated using Partners in Flight (PIF) conservation concern scores from bird conservation region (BCR) 22, the eastern tallgrass prairie ecoregion (Carter et al., 2000; Panjabi et al., 2012; http://www.rmbo.org/pif/archives/archives.html).

Nest searches were conducted from mid-April to mid-July in the same fields as were censused for birds. Two to four observers, nearly always three observers, systematically searched fields, walking approximately 10 m apart parallel to crop rows until the field was completely traversed. No-till fields were searched on a weekly basis and tilled fields on a bi-weekly basis, but nest searching effort was accounted for in estimates of nest densities. Nests were most often located by flushing incubating females or by observing birds that were carrying nesting material or food for nestlings. Nests of all species were monitored every 1–4 d until they failed or fledged at least one chick. Nest locations were marked with utility flags placed a minimum of 10 m from the nest and georeferenced (Garmin eTrex). Nests were classified as failed or successful by incorporating nest site characteristics such as nest disturbance, fledgling presence, nestling age at the previous visit, and evidence of farming practices (tire tracks, vegetation disturbance). Because we were interested in whether a nest could escape predation and farming induced failure, a nest that only fledged a cowbird ($n = 2$) was considered successful.

2.2. Statistical analysis

Program Distance 6.0 v.2.0 (Thomas et al., 2010) was used to estimate bird densities (birds/ha) for each field type, no-till and tilled. Few detections per species necessitated pooling of species to determine overall detection probabilities and densities. Observations were truncated at 40 m for analysis.

Estimates of nest densities were adjusted for search effort. To account for differential search effort, the average density of nests per 100 ha searched was calculated based on the number of times a field was searched each season; field area was multiplied by the number of searches conducted, and the number of nests was subsequently divided by this number and then multiplied by 100 to get nest density per 100 ha searched. A balanced, two-way ANOVA was used to compare nest densities between no-till and tilled fields, years, and the interaction of these factors. Most nests were found early in their nesting cycle (i.e. laying and incubation stages, 85.9%, 98/114), providing confidence that a high percentage of nests were found. Equal nest detectability was assumed between no-till and tilled fields. Fischer's Exact Test was used to assess whether nests were more likely to be initiated before soybeans had been planted in till vs. no-till fields; 31 May was the date by which 87.5% (21/24) of the study fields and nearly all fields in the area had been planted. Nest initiation dates were estimated with similar methods to that of Cox et al. (2012) except for nests that were found after hatching; nests were randomly assigned an age between the minimum age possible based on incubation length plus the number of days the nest was monitored and the mean nest cycle length.

To estimate nesting success in no-till and tilled fields, daily survival rates (DSR) were derived using the logistic-exposure method in SAS PROC GENMOD (SAS for Windows, version 9.3; SAS Institute, Cary, North Carolina; Shaffer, 2004). The logistic-exposure method uses the number of exposure days (i.e. the number of days a nest

Table 1
Ranking of models for (a) overall nest survival, (b) analysis for nests that failed due to predation, and (c) analysis for nests that failed due to farming practices in east-central Illinois, 2011–2012. Predictors for (a) included date, quadratic effect of date (date^2), field type (no-till or till), distance to edge (linear distance measured to closest change in cover type), year, and region (McLean or Champaign County). The predictor eliminated from (b) and (c) was field type. The predictor eliminated from (c) was distance to edge. In (c), only models that carried any weight (w_i) are listed.

(a)

Model	$-2\log L$	K	ΔAIC_c	w_i
Date	456.3	2	0.00	0.231
Field type × date	454.8	3	0.43	0.186
Field type + date	455.2	3	0.84	0.151
Date^2	455.9	3	1.56	0.106
Year + date	456.3	3	2.00	0.085
Constant	460.7	1	2.37	0.071
Distance to edge	459.8	2	3.50	0.040
Year + date + region	456.1	4	3.76	0.035
Field type	460.4	2	4.04	0.031
Year	460.7	2	4.36	0.026
Region	460.7	2	4.37	0.026
Field type + year	460.4	3	6.05	0.011

(b)

Model	$-2\log L$	K	ΔAIC_c	w_i
Constant	386.1	1	0.00	0.197
Distance to edge	384.3	2	0.22	0.177
Year	384.5	2	0.47	0.156
Date^2	383.1	3	1.11	0.113
Region	385.7	2	1.61	0.088
Year + date^2	381.8	4	1.77	0.081
Date	386.0	2	1.97	0.074
Year + date	384.5	3	2.44	0.058
Year + date^2 + region	381.7	5	3.70	0.031
Year + date + region	384.3	4	4.27	0.023

(c)

Model	$-2\log L$	K	ΔAIC_c	w_i
Date^2	144.4	3	0.00	0.443
Year + date^2	142.6	4	0.21	0.399
Year + date^2 + region	142.5	5	2.07	0.158

was active) when determining DSR. Estimating DSR is necessary owing biases inherent with simple comparisons of the proportions of located nests that failed/succeeded (Mayfield, 1975). The small sample size per species necessitated pooling all species for nest survival analyses. An information theoretic approach was used to explore the importance of factors that may affect nest survival. Candidate models were ranked using Akaike's information criterion adjusted for small sample sizes (AIC_c) and model weights (w_i; Burnham and Anderson, 2002).

Three sets of candidate models were developed to investigate three questions related to nest survival in soybean fields. First, factors that were predictors of overall nest survival were investigated. This model set included: field type (no-till or tilled), date (as a linear function, survival either increases or decreases over time), the quadratic effect of date (date^2), year (2011 or 2012), region (Champaign or McLean County), distance to edge (shortest linear distance to a change in cover type, including a change in crop type), and a constant survival model (Table 1a). The interaction between field type and date, the additive effect of year and date, and the additive effect of year, date, and region were also included (Table 1a). Using the midpoint daily survival values for no-till and tilled sites from the field type × date model, nesting success in no-till and tilled fields was estimated using a nest cycle length of 24.0 d, the average nest cycle length of birds in this study. The delta method was used to estimate standard errors for the overall nest survival estimates (Powell, 2007).

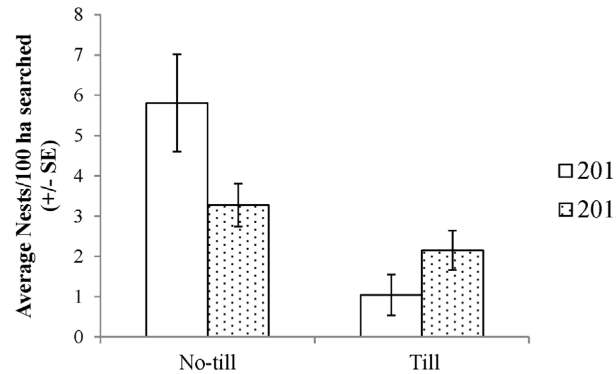

Fig. 1. Average nest density (±SE) averaged across sites and based on search effort per site in no-till and tilled fields of east-central Illinois, 2011–2012.

The second question investigated if certain factors were predictors of failure of nests that failed due to predation. This model set included all models used in the overall survival analysis. (Table 1b). All nests were included in the analysis, with nests that did not fail due to predation being considered "successful". Due to low sample size of predation events in tilled fields, "field type" could not be evaluated in this model set.

The final set of candidate models investigated factors associated with nests that failed due to farm machinery. This set of candidate models included models used in the overall survival analysis except models for distance to edge (Table 1c). Distance to edge was not included as there is no reason to expect that the probability of a nest being lost to farming practices would vary with distance to edge. All nests were again included in the analysis, with nests that did not fail due to farming being considered "successful". For this analysis, the effect of field type could not be evaluated. Daily failure rates, the inverse of daily survival, were calculated for this analysis.

3. Results

Greater densities of birds were observed in no-till (2.3 birds/ha, 95% CI = 1.8, 3.0, n = 12) than tilled fields (1.1, 95% CI = 0.7, 1.5, n = 12). The most commonly observed species were American robin (*Turdus migratorius*), common grackle (*Quiscalus quiscula*), red-winged blackbird (*Agelaius phoeniceus*), and vesper sparrow (*Pooecetes gramineus*). Twelve species were observed in tilled versus 16 in no-till fields. No-till hosted a community of birds that was of greater conservation value than tilled fields. The avian conservation significance (ACS) value for no-till (2.02) was greater than that of tilled fields (1.28; n = 24; P < 0.01). This difference in ACS value was driven by more grassland birds being present in no-till fields (e.g. dickcissel (*Spiza americana*), eastern meadowlark (*Sturnella magna*), and grasshopper sparrow (*Ammodramus savannarum*)). Two hundred and 16 ha of tilled and 209 ha of no-till soybeans were searched for nests. To provide some context of search effort, an individual searcher walked approximately 3200 km searching for nests over the course of the study. One hundred and fourteen nests were found and monitored (n = 60, 2011; n = 54, 2012). Nest densities, based on search effort, were greater in no-till soybean fields (4.5 nests/100 ha, SE ± 0.58, n = 12) than tilled (1.6 ± 0.58, n = 12; F = 12.90; $P \le 0.01$; Fig. 1). A significant interaction was found between nest density and year; the difference in nest density between no-till and tilled fields was less in 2012 than in 2011 (F = 4.93; P = 0.04).

The most common nesting species were American robins (n = 35), vesper sparrows (n = 27), and mourning doves (*Zenaida macroura*) (n = 22). Twelve nesting species were observed in no-till versus six species in tilled fields (Table 2). American robins were the most common nesting species in both no-till and tilled fields.

Table 2
Species composition of all nests found in (a) no-till and (b) tilled soybean fields in East-Central Illinois, 2011–2012. Number of successful nests includes any nest that fledged ≥1 chick.

(a)

Species	No. of nests found	No. of successful nests
American robin (*Turdus migratorius*)	31	7
Vesper sparrow (*Pooecetes gramineus*)	26	8
Mourning dove (*Zenaida macroura*)	22	8
Red-winged blackbird (*Agelaius phoeniceus*)	7	0
Killdeer (*Charadrius vociferus*)	3	2
Brown thrasher (*Toxostoma rufum*)	4	0
Eastern meadowlark (*Sturnella magna*)	2	0
Dickcissel (*Spiza americana*)	1	0
Ring-necked pheasant (*Phasianus colchicus*)	1	0
Upland sandpiper (*Bartramia longicauda*)	1	0
Field sparrow (*Spizella pusilla*)	1	0
Totals	99	25

(b)

Species	No. of nests found	No. of successful nests
American robin	4	2
Red-winged blackbird	4	0
Killdeer	3	1
Horned lark (*Eremophila alpestris*)	2	0
Dickcissel	1	0
Vesper sparrow	1	0
Totals	15	3

Horned larks (*Eremophila alpestris*) were only found nesting in tilled fields, while mourning dove, brown thrasher (*Toxostoma rufum*), eastern meadowlark, field sparrow (*Spizella pusilla*), upland sandpiper (*Bartramia longicauda*), and ring-necked pheasant (*Phasianus colchicus*) were only found in no-till. A greater percentage of nests were initiated in no-till (68.7%, 68/99) before 31 May, the date by which nearly all fields had been planted, compared to tilled fields (33.3%, 5/15; $P = 0.01$; Fig. 2).

Of the 114 nests monitored, 28 (24.6%) fledged at least one chick. Of the 86 nests that failed, 65.1% ($n = 56$) were due to predation, 24.4% ($n = 21$) to farm machinery, and 10.5% ($n = 9$) to abandonment. All nests that failed due to farm machinery failed during crop planting. Of the nests of species known to be parasitized by brown-headed cowbirds ($n = 44$ nests), 20 were parasitized, 15 of which were vesper sparrows.

The models that best predicted overall nest survival included date and field type (Table 1a). No-till had greater nest success than tilled fields, though the confidence intervals overlap, likely due to small sample size (Fig. 3). The midpoint DSR estimate was 0.906 (95% CI: 0.853–0.941) for tilled and 0.934 (95% CI: 0.916–0.952) for no-till. By raising these estimates of DSR to the power of 24.0, the average nest cycle length for species in this study, the estimated nest success rate was 9.4% ± 1.9% and 19.4% ± 1.5% for tilled and no-till fields, respectively. The model averaged estimate of DSR of all nests in both no-till and tilled fields, estimated by using observed mean values for continuous variables and proportional values for categorical variables (Shaffer and Thompson, 2007), was 0.924 (95% CI: 0.904–0.940).

For nests that failed due to predation, the most supported models suggested that predation was constant and that nests closer to an edge were more susceptible to predation. In contrast to nests that failed due to predation, the models for the analysis of nests that failed due to farming practices indicated strong effects of date^2 (Fig. 4) and year (Table 1c).

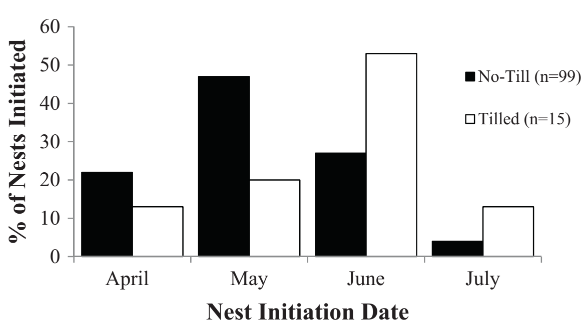

Fig. 2. Percentage of nests initiated per month of the nesting season for no-till and tilled sites in east-central Illinois, 2011–2012.

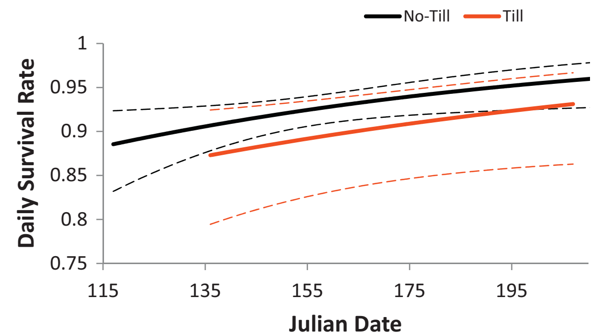

Fig. 3. Daily survival rates across the breeding season of all nests based on predicted DSR values of the model field type × date in east-central Illinois, 2011–2012. Dashed lines indicate 95% confidence intervals of predicted values.

4. Discussion

No-till supported greater densities of birds, greater densities of nests, and an avian community of greater conservation value than tilled fields. Nests in no-till also had a greater survival rate than nests in tilled fields, but nest survival in both field types was low. Predation and farm machinery were the leading causes of nest failure. Overall, no-till provided greater conservation value for birds than tilled fields. Grassland species such as upland sandpiper, an Illinois state endangered grassland species, and ring-necked pheasant were only found nesting in no-till fields. Three grassland species, eastern meadowlark, dickcissel, and grasshopper sparrow were also largely responsible for the differences in the ACS between no-till and tilled fields. Crop residue (corn stalks) from the previous growing season and weedy vegetation in no-till likely resulted in birds using no-till fields (Basore et al., 1986; Flickinger and Pendleton, 1994), particularly early in the nesting season when

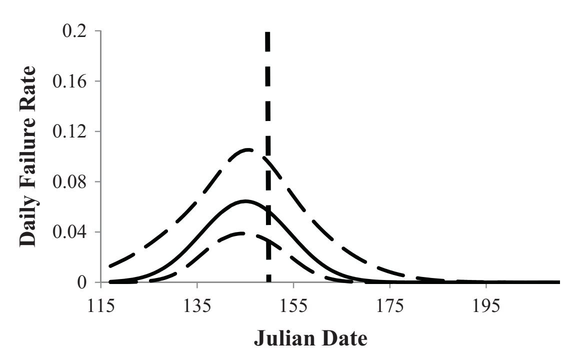

Fig. 4. Daily failure rates across the breeding season of nests that failed due to farming based on predicted values for the model of the quadratic effect of date (±95% CI) in east-central Illinois, 2011–2012. Curved dashed lines indicate 95% confidence intervals for predicted values while the horizontal dashed line represents 31 May, the date by which nearly all sites were planted.

weedy vegetation is most abundant. The greater vegetation density and structure (Appendix 2) in no-till fields also provided greater concealment for nests, resulting in greater nesting success.

Similar to previous studies of nesting birds in row crops (Basore et al.,1986; Lokemoen and Beiser, 1997), significantly greater densities of nests were found in no-till than tilled fields. Nest densities (without accounting for effort) were similar to those of Basore et al. (1986): 4.0 nests/100 ha in tilled compared to the estimate of 7.6, and 36.0 nests/100 ha in no-till fields compared to the estimate 41.6. While more nests were found in no-till than tilled fields, the difference in nest density between field types diminished between 2011 and 2012 (Fig. 1). This difference could be the result of variability between 2011 and 2012 fields, but the difference may also be due to the extreme drought experienced in 2012 (State Climatologist Office for Illinois, 2012). Species composition of nesting birds changed from 2011 to 2012; whereas in 2011 American robins were the most common nesting species, vesper sparrows were the most common in 2012. No-till fields can become highly compacted during extreme drought, limiting invertebrate availability (Schrader and Lingnau, 1997). Food and nest resource (mud in the case of robins) limitations during drought could be a factor in the observed difference.

The analysis of overall nest success suggested that date and the interaction of field type and date were the best predictors of nest survival; nest success in both no-till and tilled sites increased as the nesting season progressed, with survival in no-till being consistently greater. This increase in nest survival throughout the breeding season is likely due to reduced farming activity after planting and the increase in vegetative cover as crops grow that may hide nests from nest predators. Date appeared in the best supported models, indicating that temporal effects of predator behavior and farming activity best predicted nest survival throughout the season.

Predation was the leading cause of nest failure, causing 65.1% of all failures. The deployment of video cameras at selected nests identified coyotes (*Canis latrans*) and thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) as nest predators (VanBeek, 2012). These species have also been documented depredating nests in grasslands (Renfrew and Ribic, 2003), and it is likely that agricultural fields share the same predator community with nearby grasslands. Nests that were closer to an edge were also more likely to be preyed upon, again indicating heavy predation pressure by predators likely found in nearby grass filter strips (Benson et al., 2013).

Nest failure due to farm machinery accounted for 24.4% of nest failures. Date^2 strongly predicted nest failure, indicated by a short, sharp increase in nest failures during the time that fields were being planted (Fig. 4). While the additional tillage activity associated with tilled fields might be expected to result in even greater nest failure early in the season due to farming activity, tillage generally occurred in fall or early spring before nesting activity in the study area; 66.6% of nests being initiated in tilled fields after 31 May, well after tillage activity. Therefore birds nesting in tilled fields were not exposed to more mechanical disturbances than birds nesting in no-till. Birds nesting in no-till tended to nest early in the season (Fig. 2), potentially exposing more nests to destruction by farm machinery and creating an ecological trap.

Previous research has suggested that fields under conservation tillage, including no-till, may act as ecological traps, habitat that attracts individuals that ultimately do not reproduce (Best, 1986). The relatively low nesting success in both no-till and tilled fields may suggest these fields are ecological traps for grassland birds that could have bred in nearby grasslands, such as filter strips, that are often present in agricultural landscapes. Nest survival estimates were compared to previous studies conducted in grasslands embedded in agriculture in Illinois and Iowa. The survival estimates for nests in tilled (9.4%) and no-till (19.4%) fields were within the range (6.0–34.8%) of studies of grassland birds in filter strips in agricultural landscapes of Iowa and Illinois (6.0–34.8%; Davros, 2005; Henningsen and Best, 2005; Kammin, 2003). While nest success in small grasslands in agricultural landscapes is greater than was estimated in this study (28.0–38.0%; Walk et al., 2010b), nest success is low throughout the agricultural landscape.

A farming activity that could potentially be “managed” for the benefit of wildlife is planting date. If soybean planting could be delayed until early June, fields would remain undisturbed longer, coinciding with the time period of greatest nesting activity in soybeans. The average planting date in this study was 18 May, and all nests that were destroyed would have finished their nesting cycle by 1 June. Delayed planting could allow nests that failed due to farming sufficient time to complete their nesting cycle. Alternatively, earlier planting may provide a longer breeding season without disturbance.

Despite potential benefits for nesting birds, delayed planting impacts the economic profitability of growing soybeans. In Illinois, soybean yields decrease by 33.6 kg/ha for every day soybean planting is delayed in early June (Emerson, 2012). Delayed farming activity was found to be an effective conservation tool in Northeastern United States haylands where a monetary incentive was used to increase participation and therefore increase nest success of grassland birds (Perlut et al., 2011).

As row crop agriculture continues to intensify in the Midwest and other historically grassland dominated landscapes, it is important to understand what farming practices could potentially benefit birds in terms of increased nesting opportunities. If you apply the raw nest densities found in this study and extrapolate them to the amount of soybean acreage in Illinois, approximately 750,000 nests may be in no-till per y compared to 139,000 in tilled fields per y. To provide additional context, approximately 1.13 million hectare of grassland, including working grasslands such as hay and pasture, exist in Illinois. Nest densities must be at least two times greater in grasslands in order to exceed the number of potential nests in no-till soybeans. Although a low percentage of nests in soybeans are successful, the prevalence of no-till row crops as compared to other natural habitats suggests that for some species specializing in arable lands, such as vesper sparrows, a large percentage of young are being produced in row crop fields. Furthermore, in order to sustain species of conservation concern such as the dickcissel and upland sandpiper in intensive agriculture landscapes, we must understand both positive and negative effects of tillage practices.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.agee.2013.12.007.

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